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FINAL REPORT FOR THE C-130 RAMP TEST #2 OF A HYDREMA MINE CLEARING VEHICLE

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14. ABSTRACT

This report presents the results of the follow-on C-130 ramp test for the Hydrema Mine Clearing Vehicle. The test was conducted using a reconfigurable mock C-130 ramp. The objective was to determine if the Hydrema met the C-130 air transportable axle load limitations of 13,000 lbs per axle. Sixteen channels of instrumentation were recorded to determine the weight of the vehicle as it traversed up the test ramp and onto the floor of the plane.

15. SUBJECT TERMS
Hydrema, Mine Area Clearance Equipment, C-130 Load Cell Test, MACE, Mine Clearance Vehicle, MCV, C-130 air transportability test of Hydrema MCV or MACE

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1.0 INTRODUCTION

1.1 General

The Air Force Research Laboratory (AFRL) located at Tyndall Air Force Base (AFB) in Panama City FL, has coordinated with the Physical Simulation Team (PST) at the Tank Automotive Research, Development, and Engineering Center (TARDEC) located in Warren MI, to perform a follow-on C-130 ramp test on the Hydrema Mine Clearing Vehicle (MCV). This test is being conducted to determine if the new bogie system on the Hydrema will allow the vehicle to meet the requirements to be considered C-130 transportable.

The Air Force has strict specifications for loading any vehicle onto a C-130. Those specs state that the axle weights of the vehicle can not exceed 13,000 lbs. This weight limit applies to the ramp of the plane as well as the floor of the aircraft.

1.2 Testing of the System

The test was conducted on September 26 and 27, 2007. The test consisted of 10 preliminary runs up the instrumented mock C-130 ramp. These runs were used to adjust the newly developed bogie system for optimal performance. Three final test runs were conducted with the ramp at a 12 degree angle, and those results will be presented in this report.

The Hydrema vehicle was driven slowly up the ramp shown in Figure 1. The ramp has 16 instrumented plates that are shown as letters A-P. Each plate has four load cells, one in each corner, and is capable of measuring up to a 20,000 lb load. The vehicle made several stops as it climbed the ramp in order to take clear readings of the tire forces at various locations.

In order for the Hydrema to be considered C-130 transportable by the US Air Force, it must not exceed an axle load of 13,000 lbs anywhere on the ramp. To achieve this goal, the Hydrema vehicle has a set of bogie wheels in the front and a double set of bogie wheels in the rear that are installed just to load the vehicle onto the aircraft.

2.0 TEST SETUP

2.1 Test Equipment

In order to monitor the weight of a vehicle as it is loaded into a C-130, two axial load measurement ramps have been designed, fabricated, and instrumented with load cells (See Figure 1). The load cells are wired to a data acquisition system and data is sampled continuously while the vehicle is loaded on and off the ramp. The ramp has 16 instrumented plates (A-P in Figure 1), that are 32” square. Each plate has four 5,000 lb load cells, one in each corner. This allows each plate to record loads up to 20,000 lbs. The load cells are wired to a summing box, also located on the bottom of the plate, where the readings from all 4 load cells are added together and sent to the data acquisition system. The plates can be reconfigured to take measurements as the vehicle climbs the ramp, on the floor of the plane, or a combination of both. The ramp angle can be changed from 12 to 15 degrees. For this test, the ramp will be left in the 12 degree configuration.

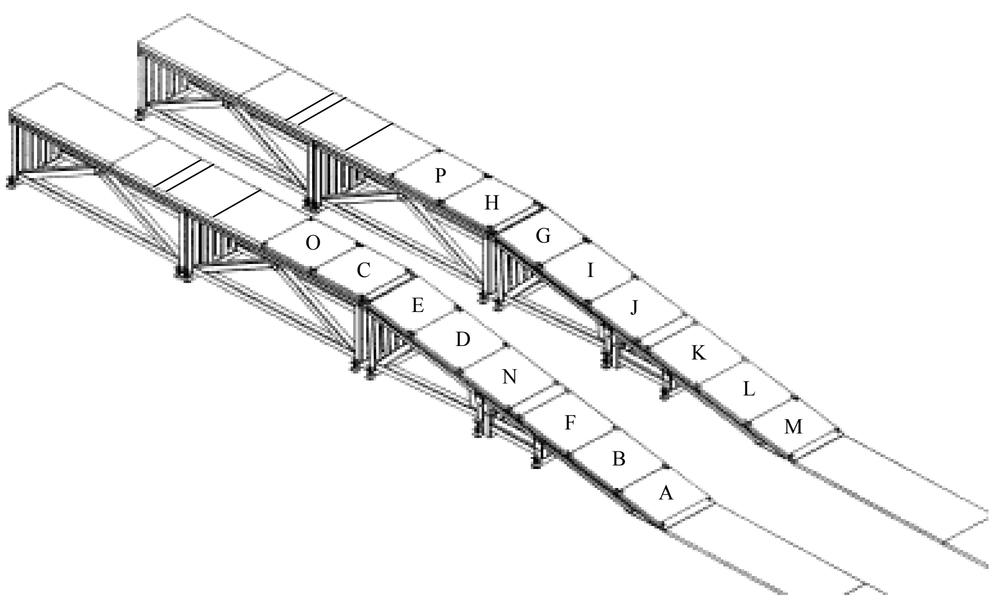

Figure 1. C-130 Measurement Ramps

2.2 Vehicle Configuration

The Hydrema MCV is a four wheeled vehicle that weighs over 36,000 lbs. After the first attempt to use a bogie wheel system to lower the axle weight of the vehicle failed, the engineers at Hydrema designed a new system for this follow-on test. The new bogie system is shown in figures 2 and 3. The new bogie wheel system is mounted on the front and rear of the vehicle and controlled by the main hydraulic power supply. It is believed that these bogie axles will allow the Hydrema to meet the 13,000 lb axle limit.

Figure 2. Hydrema Front Bogie Axle

Figure 3. Hydrema Rear Bogie Axles

The Hydrema also has its flail system rotated and stowed on the rear of the vehicle (Figure 4). All the chains and hammers for the system have been removed for transport.

Figure 4. Stowage of flail system

The axle spacing and overall length of the vehicle in its C-130 transport configuration are shown in Figure 5.

2.3 Test Procedure

The test plan is to drive the Hydrema up the ramp and determine where the highest axle load readings will be found. After determining the worst case position, adjustments will be made to the bogie system to optimize the system. Upon achieving acceptable results, 3 final runs will be completed to show that the data is correct and repeatable. Due to small changes in position and alignment of the vehicle, the weight changes slightly from run to run. The final axle weight will be obtained by taking the average of the three runs.

3.0 Results

It was determined that the peak axle loads were measured as the main vehicle axles crossed over the hinge pin. This is where the top of the ramp is connected to the fuselage of the aircraft. For the three final test runs, the vehicle was paused just before first contact with the hinge pin, when the tire is centered on the hinge pin, and just after it clears the hinge.

Figure 5. Vehicle dimensions

A total of 13 optimization test runs were completed. During these test runs the hydraulic pressure used in both the front and rear bogie axles were adjusted along with changing the tire pressures for the main axles. The tire and hydraulic pressures used for the final test runs are shown in Table 1 below.

Tire Pressures	
Main Hydrema Axles	45 psi
Bogie Axles	100 psi
Hydraulic Pressures	
Front Bogie System	2510 psi
Rear Bogie System	2610 psi
Fuel level in vehicle	Each tank was ~¼ full.

Table 1. Tire and Hydraulic Pressures

The results for the final 3 test runs can be found in the Appendix section of this report. Appendix A shows the axle weights for each individual test as the vehicle climbs the ramp. Appendix B is an average of the 3 runs. This data shows that at no time during the loading of the Hydrema does any single axle exceed the 13,000 lb load limit. The worst case found was during test run 3 where the rear axle hit a peak of 12,240 lbs as the tire was centered on the hinge pin.

4.0 Conclusion

The data from this testing supports that the Hydrema MCV passes the axle restrictions placed on vehicles that are considered for C-130 transport. As long as the tire pressures and hydraulic pressures in the bogie axles are maintained, further testing should not be needed.

Appendix A
Ramp data recorded at 12 degree angle. All weights are in pounds.

Test 23	Front Bogie	Front Wheel	Rear Wheel	Rear Bogie 1	Rear Bogie 2
Base of Ramp (Plates A + M)	7825	10834	5557	7623	7105
Plates B + L	7592	10034	5878	6725	6648
Plates D + I	7437	11271	8966	5396	6776
Before Hinge (Plates E + G)	7317	11213	12004	6784	7259
On Hinge (Plates E+C & G+H)		11653	12171		
After Hinge (Plates C + H)	7224	10342	7994	7141	7317
Test 24					
Base of Ramp (Plates A + M)	7588	11107	7694	7589	7112
Plates B + L	7600	10374	5809	6734	6689
Plates D + I	7275	10971	8968	5466	6892
Before Hinge (Plates E + G)	7151	11307	12004	6872	7238
On Hinge (Plates E+C & G+H)		11797	11843		
After Hinge (Plates C + H)	7030	10200	7990	7248	7386
Test 25					
Base of Ramp (Plates A + M)	7630	10870	5960	7550	7110
Plates B + L	7580	10380	5890	6750	6700
Plates D + I	7380	11190	9160	5580	6850
Before Hinge (Plates E + G)	7210	11480	11770	6870	7280
On Hinge (Plates E+C & G+H)		11940	12240		
After Hinge (Plates C + H)	7110	10080	8210	7180	7370

Appendix B
Average axle weights for the 3 final test runs.

Average Weights

	Front Bogie	Front Wheel	Rear Wheel	Rear Bogie 1	Rear Bogie 2
Base of Ramp (Plates A + M)	7681	10937	6404	7587	7109
Plates B + L	7591	10263	5859	6736	6679
Plates D + I	7364	11144	9031	5481	6839
Before Hinge (Plates E + G)	7226	11333	11926	6842	7259
On Hinge (Plates E+C & G+H)		11797	12085		
After Hinge (Plates C + H)	7121	10207	8065	7190	7358